H Block

Implications of Allocating the H Block for Mobile Services

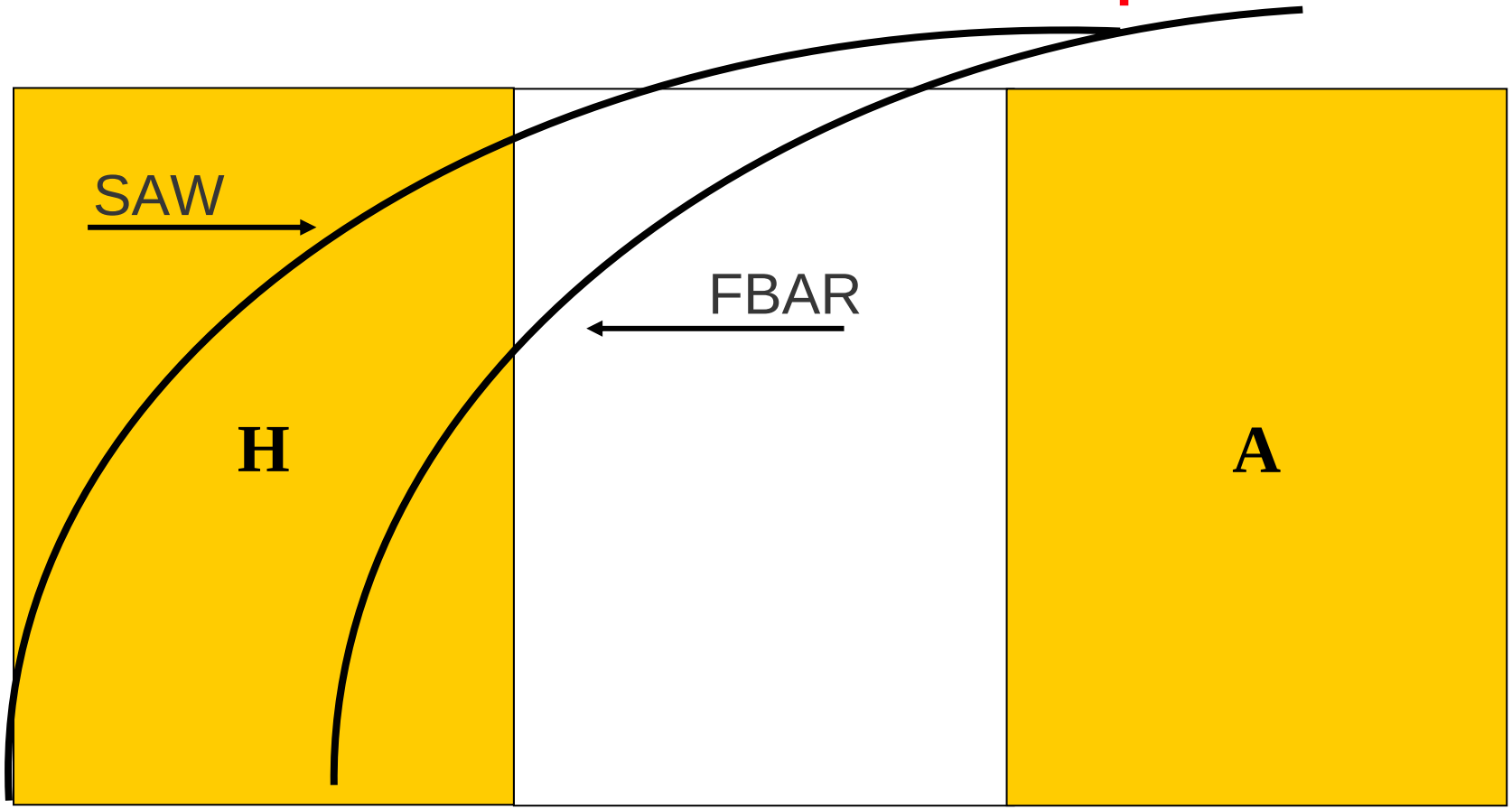
September 1, 2004

Table of Contents

H Block Overview

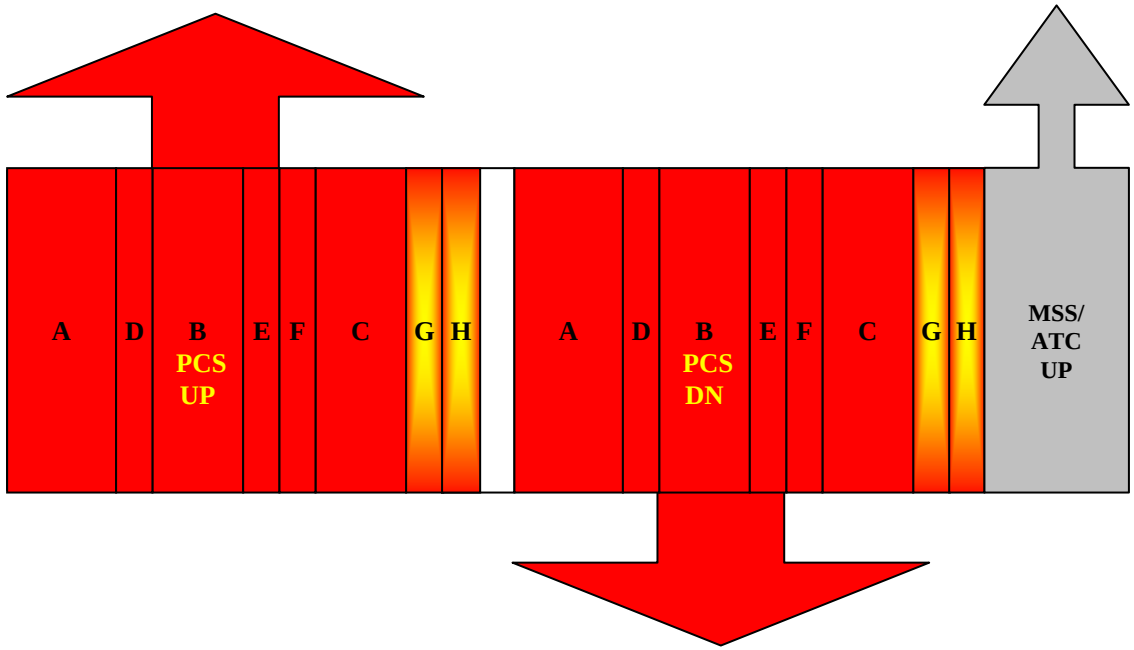
- The mere 10 MHz of separation between the H Block and PCS A Block creates both both (i) out-of-band (OOB) and (ii) so-called “overload” interference concerns with with respect to an H Block mobile service allocation.
- OOB interference can be alleviated by requiring compliance with the -76 dBm OOB OOB emissions criteria set forth in PCS industry standard, TIA 98-F.
- “Overload” interference concerns arise because the H Block transmit band impacts impacts the duplexer receive band in millions of existing PCS handsets.
- Tests on H Block “overload” interference were conducted at Nokia Labs during the the last week of August 2004.
- Test results show harmful interference will occur to millions of existing PCS handsets handsets in the presence of a H Block signal.
    - One active H Block device could prevent another nearby handset from placing and and receiving a call.
    - Both devices do NOT have to be engaged in a call.
    - In PCS today, all PCS handsets are fully operable and non-interfering at any distance distance with respect to each other.
    - Performance of all duplexers vary dramatically over their normal operating temperature temperature range.
- If H Block is allocated for mobile services, **significant** power limitations (likely throughout the H Block transmit band) must be imposed **along with** the OOB emissions and receiver blocking criteria set forth in PCS industry standard, TIA 98-F, 98-F, to avoid adverse impacts to PCS consumers.
- Alternatively, the Commission should consider allocating the H Block for low-power power unlicensed or any other non-mobile service.

Illustration of the H Block "overload" problem



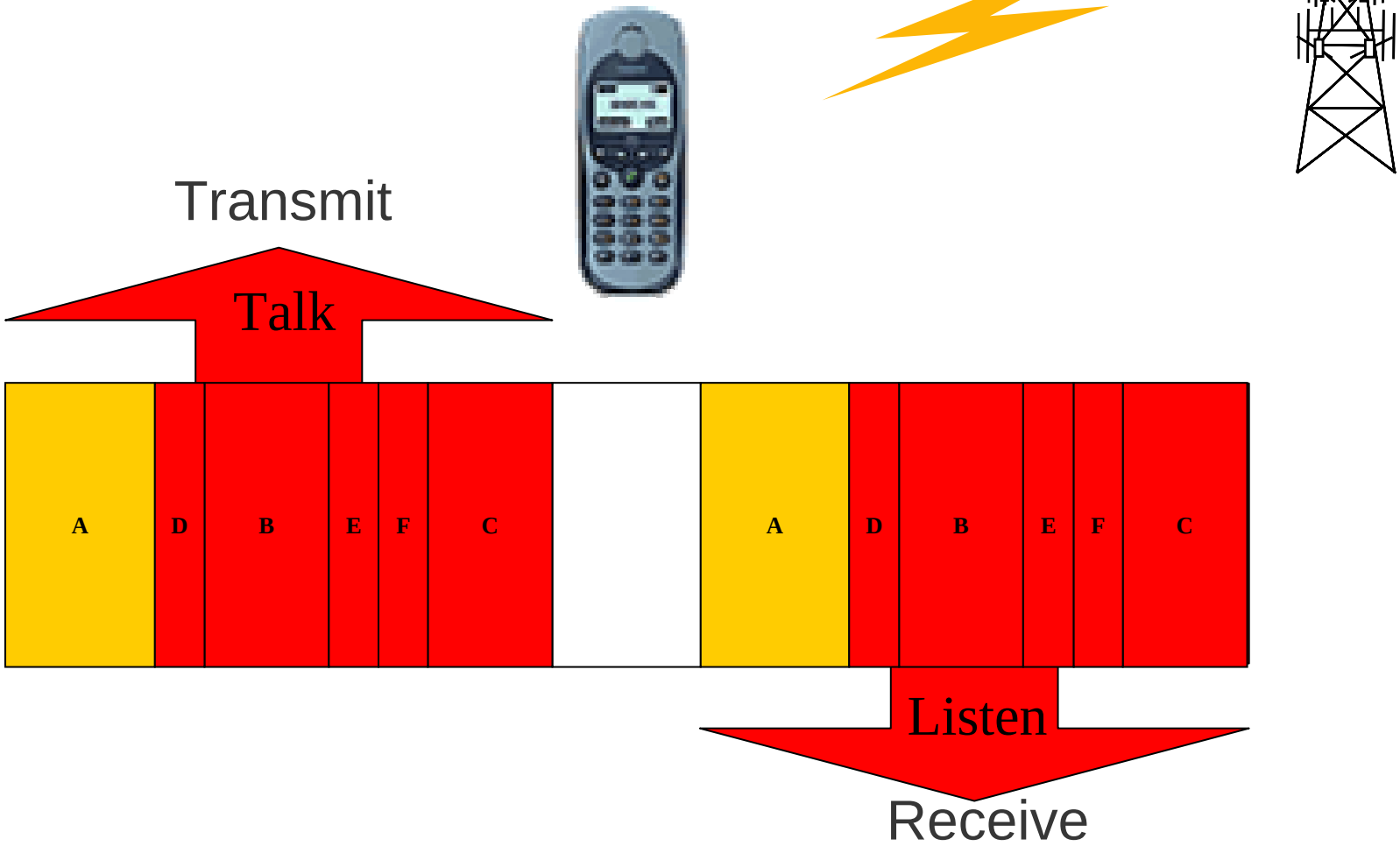
- The duplexers in millions of PCS handsets deployed today today would be "listening" to the H Block transmissions. transmissions.
- These duplexers do not filter out the H Block.

1850- 2020 MHz Band Plan



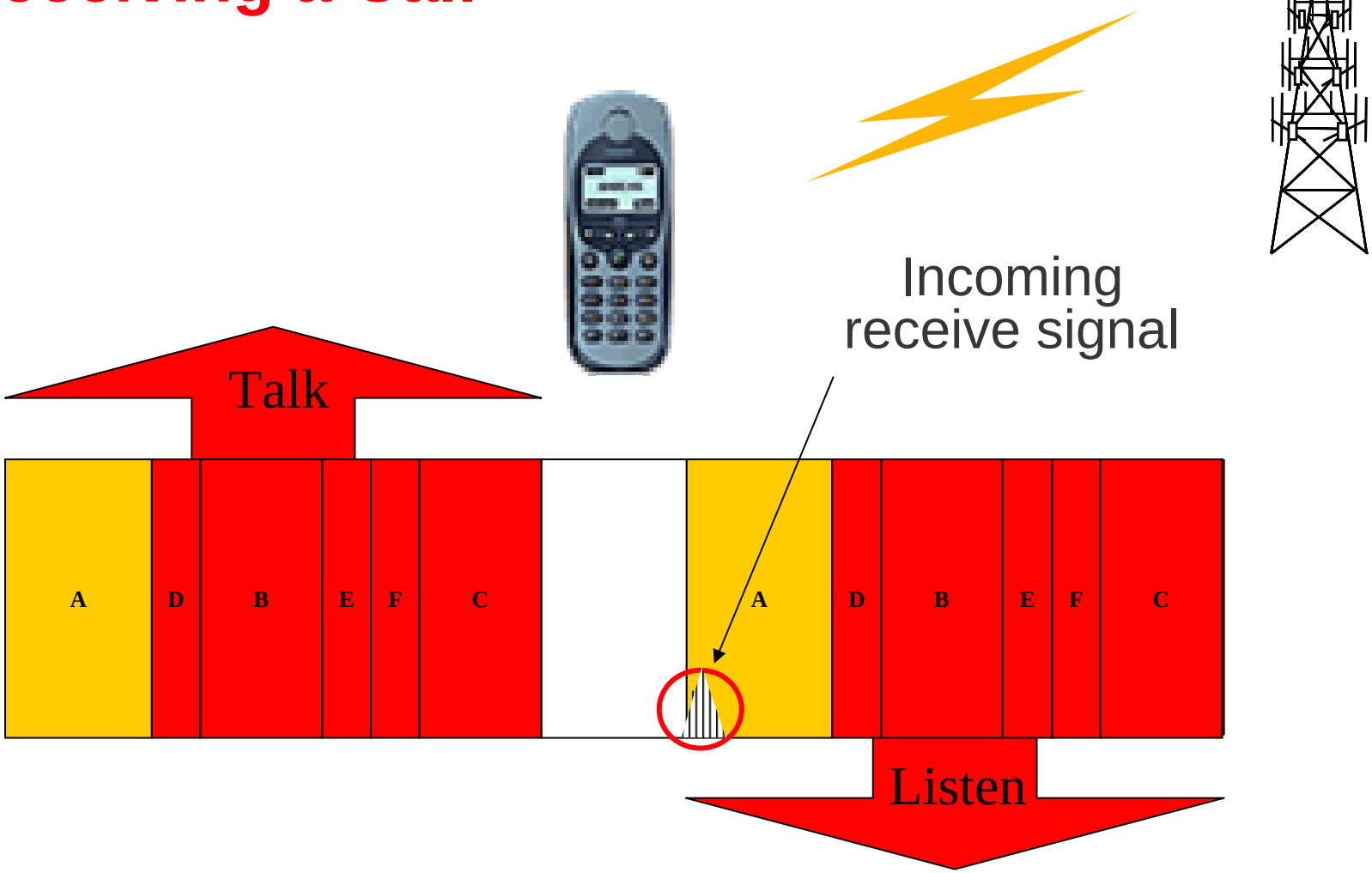
- H block is 10 MHz from existing PCS A block receive band.
- H block location is currently allocated for unlicensed PCS services. services.
- Allocation of H block for mobile services poses several technical technical challenges including protection to PCS and MSS/ATC services.

How a PCS Handset Works



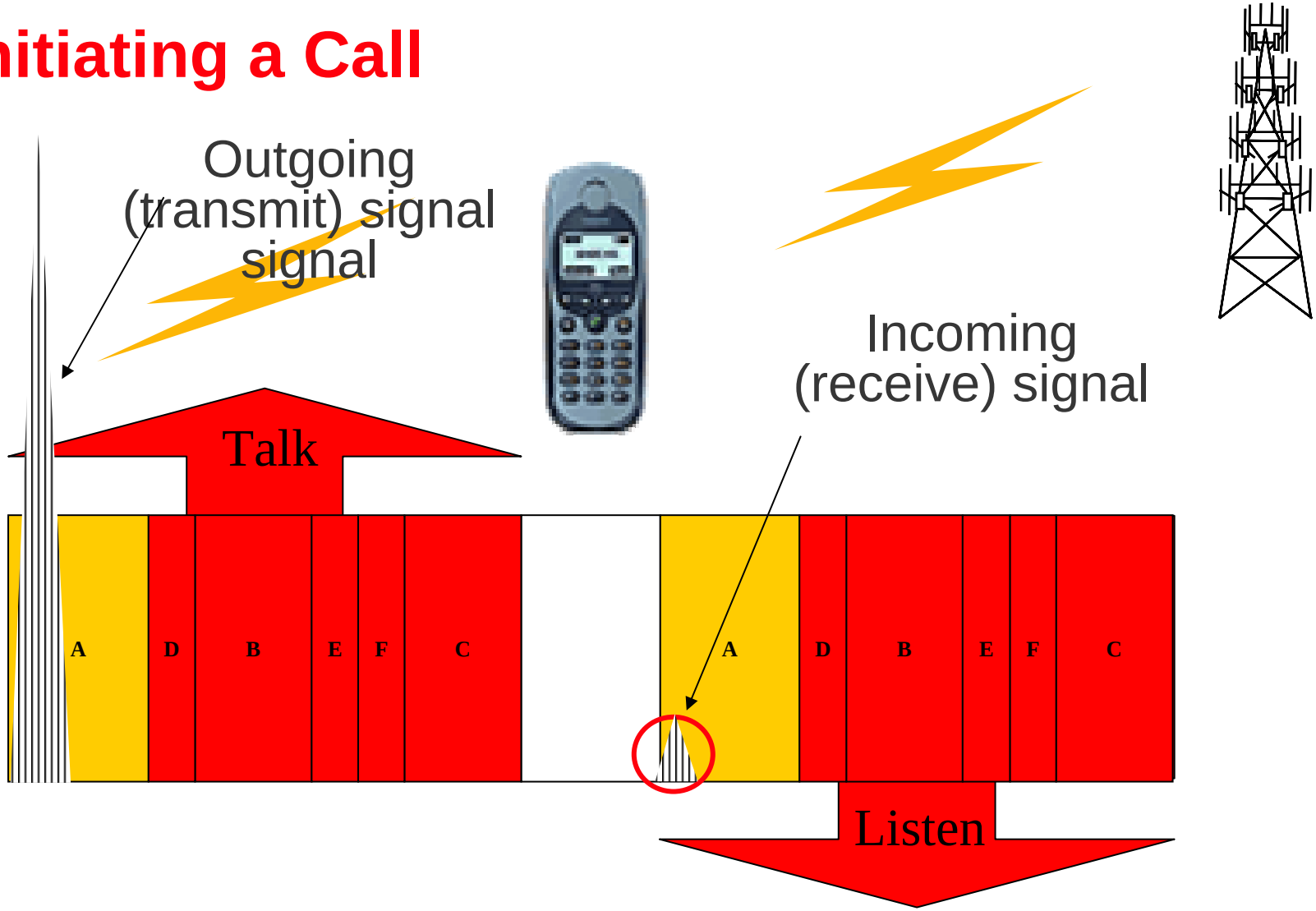
- The handset “Transmits and Receives” at the same time. time.
- It may do so on any PCS block.

Receiving a Call



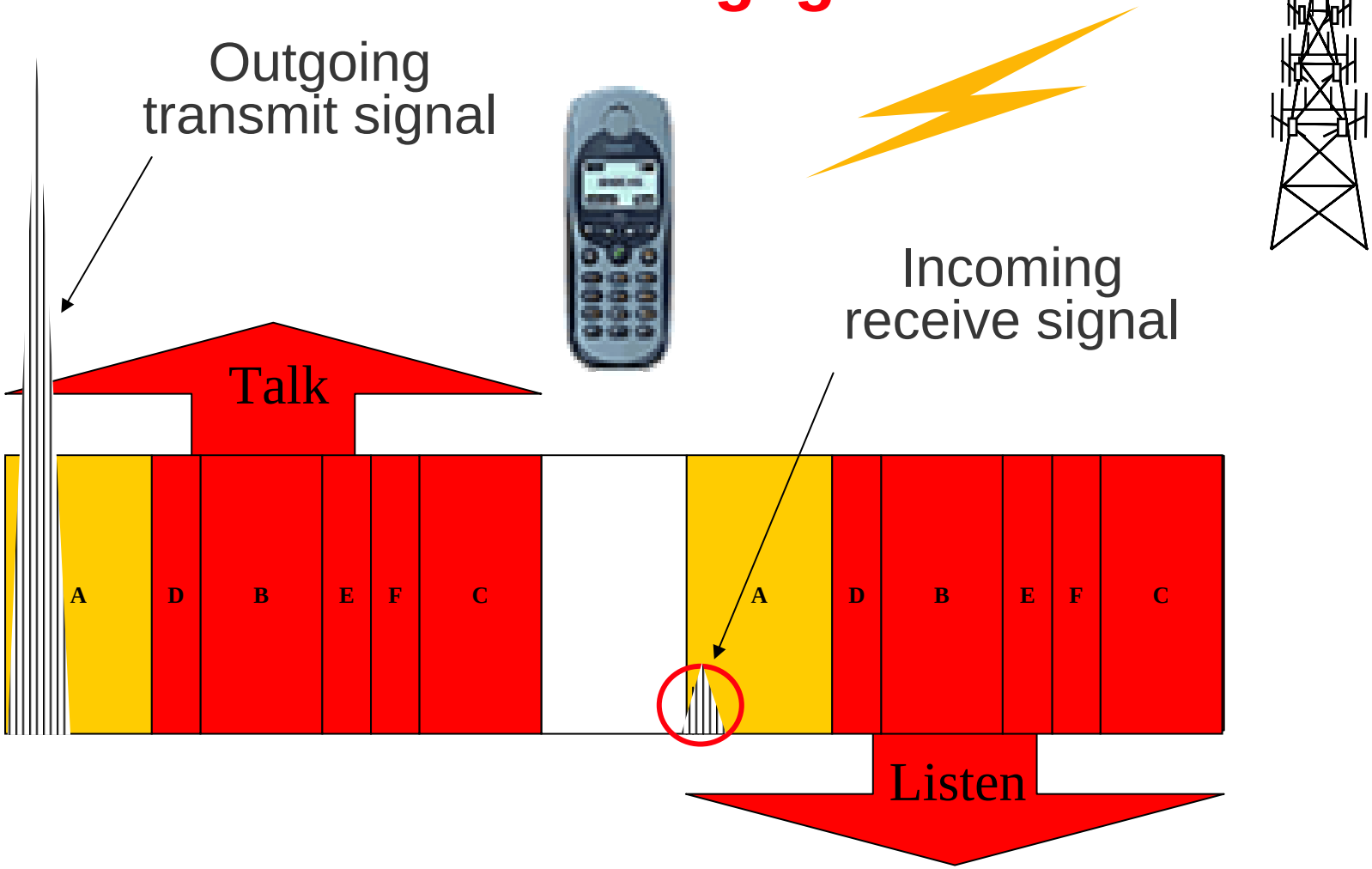
- Handset “rings” when signaled from the base station. station.

Initiating a Call



- Handset signals the base station and receives “dial tone”. tone”.

An A Block Handset Engaged in a Call

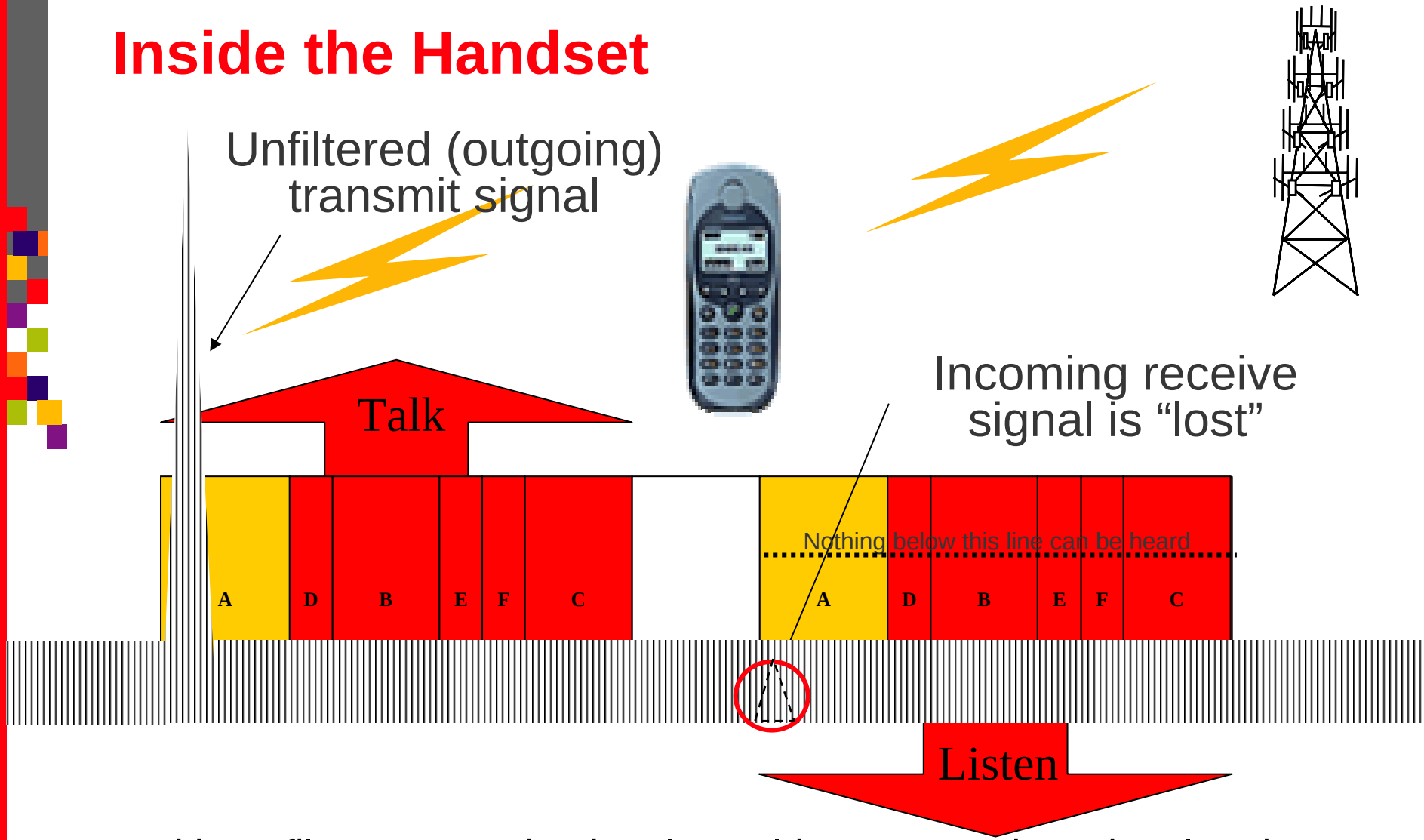


- The transmit signal has billions of times the RF “energy” than the receive receive signal.
- Because of filters (duplex), the transmit and receive signals do not interfere with each other.

Inside the Handset

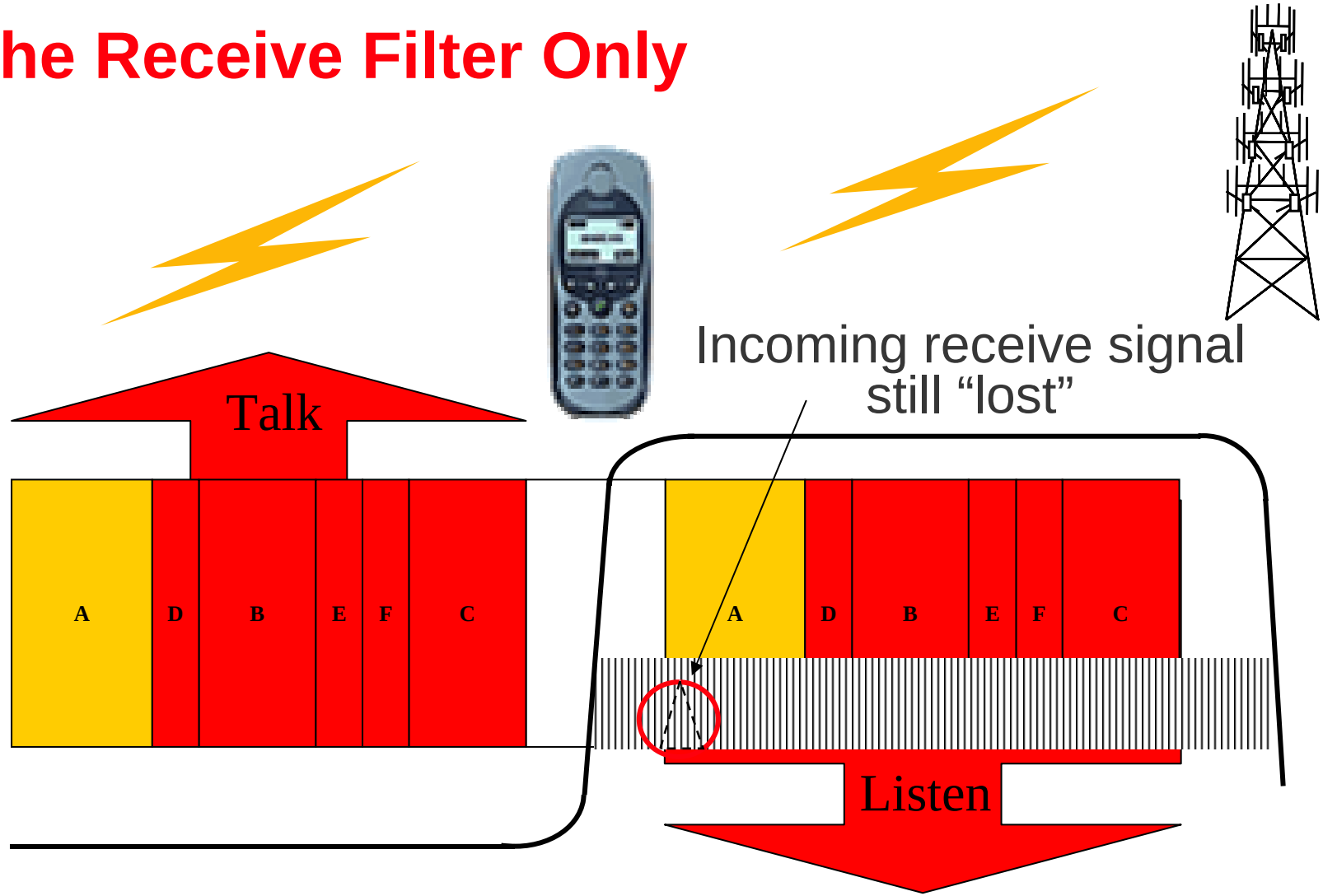
- Since the outgoing signal needed to “Transmit” “Transmit” is billions of times greater than the the incoming signal to “Receive,”
- The handset manufacturers are challenged to keep the “Transmit signal” and “Receive signal” signal” isolated from each other.
- That’s what filters do successfully today.
- Transmission from an H Block device falls on the wrong side of PCS duplex filters and will cause interference problems for PCS handsets. handsets.
- Here’s why:

Inside the Handset



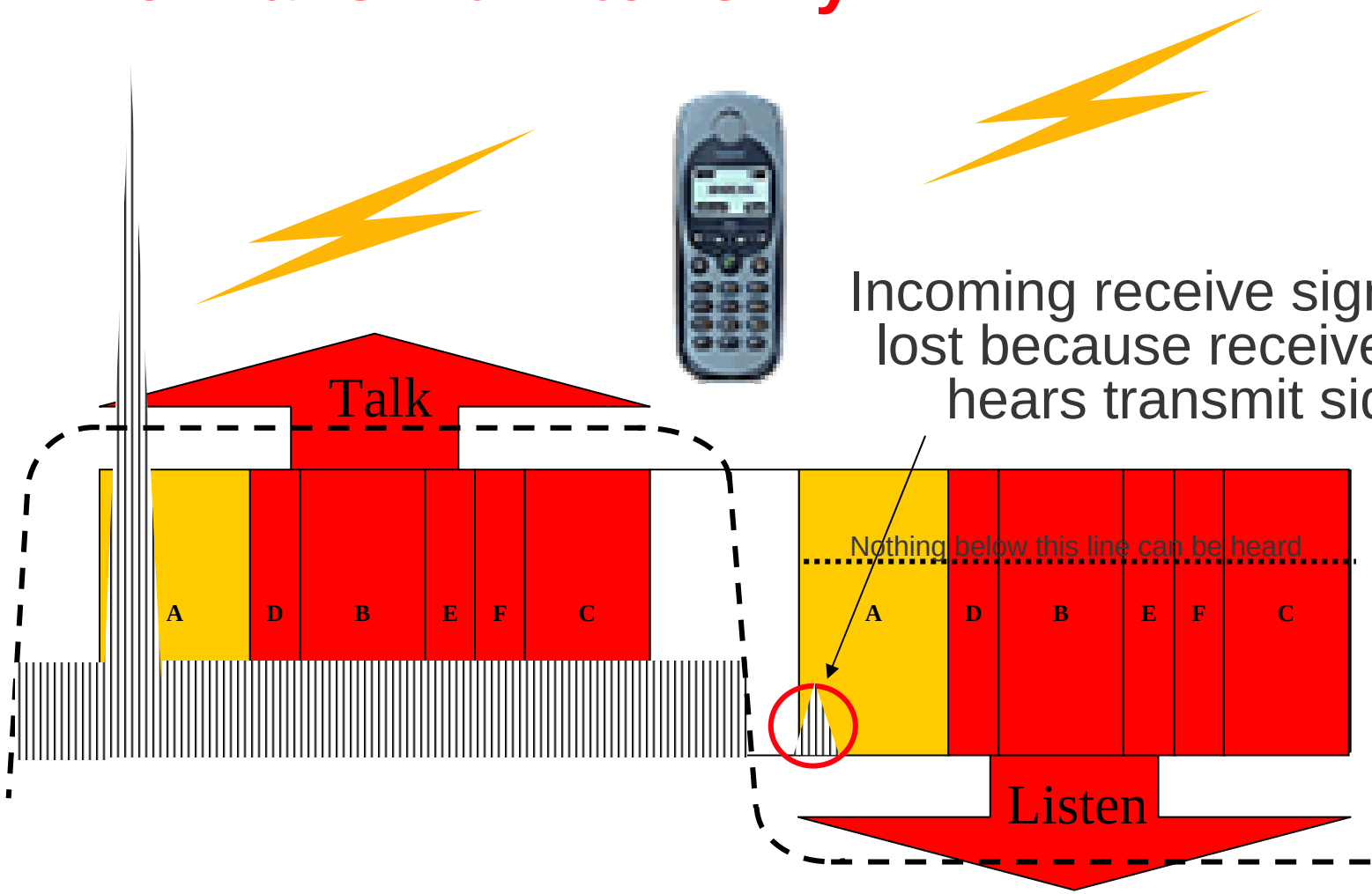
- Without filters, transmit “signal” would cause receive “signal” to be to be lost for two reasons:
  - The “transmit signal power” and unwanted “transmit signal emissions” emissions” that occur across the PCS band.

The Receive Filter Only



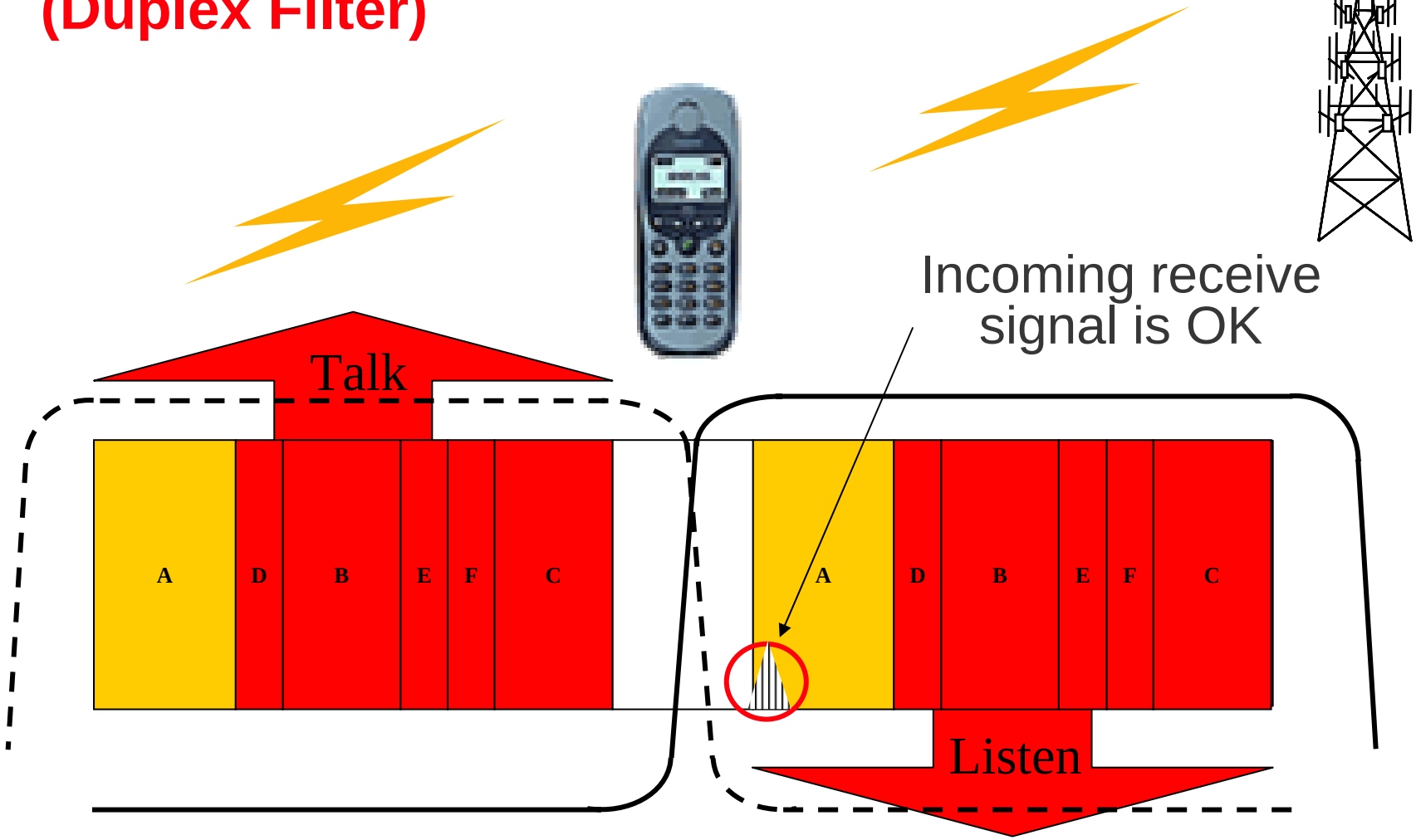
- The receive filter removes the signal coming from the transmit signal, but cannot remove the signal emissions that are inside its its own filter range. Another filter is necessary on the transmit side. side.

The Transmit Filter Only



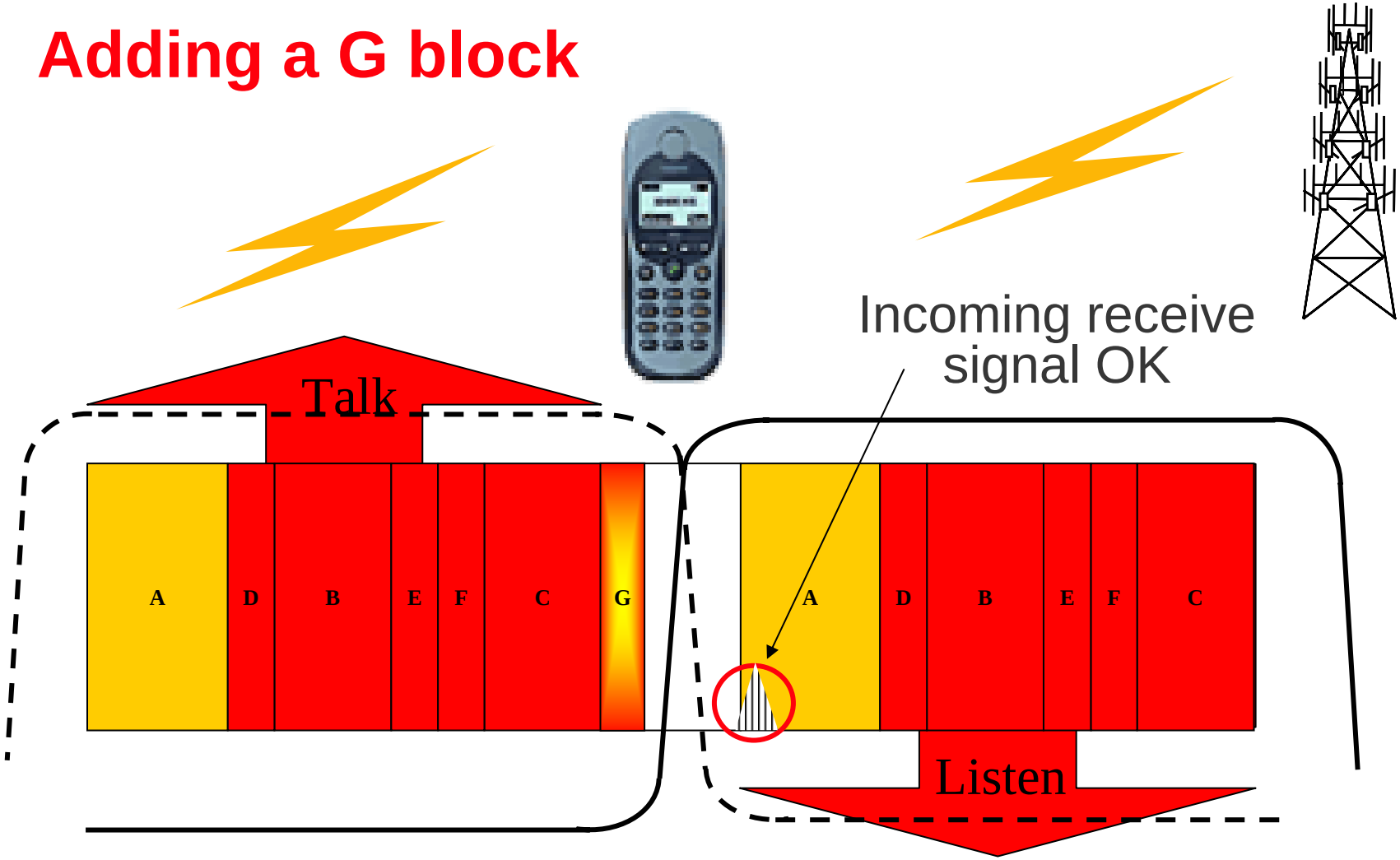
- The transmit filter passes the transmit signal to the base station, and and cleans up the transmit emissions in the receive band, but because because the transmit signal is billions of times more powerful than the than the receive signal, the receive signal can’t be detected. Both filters must work together.

Both Filters Working Together (Duplex Filter)



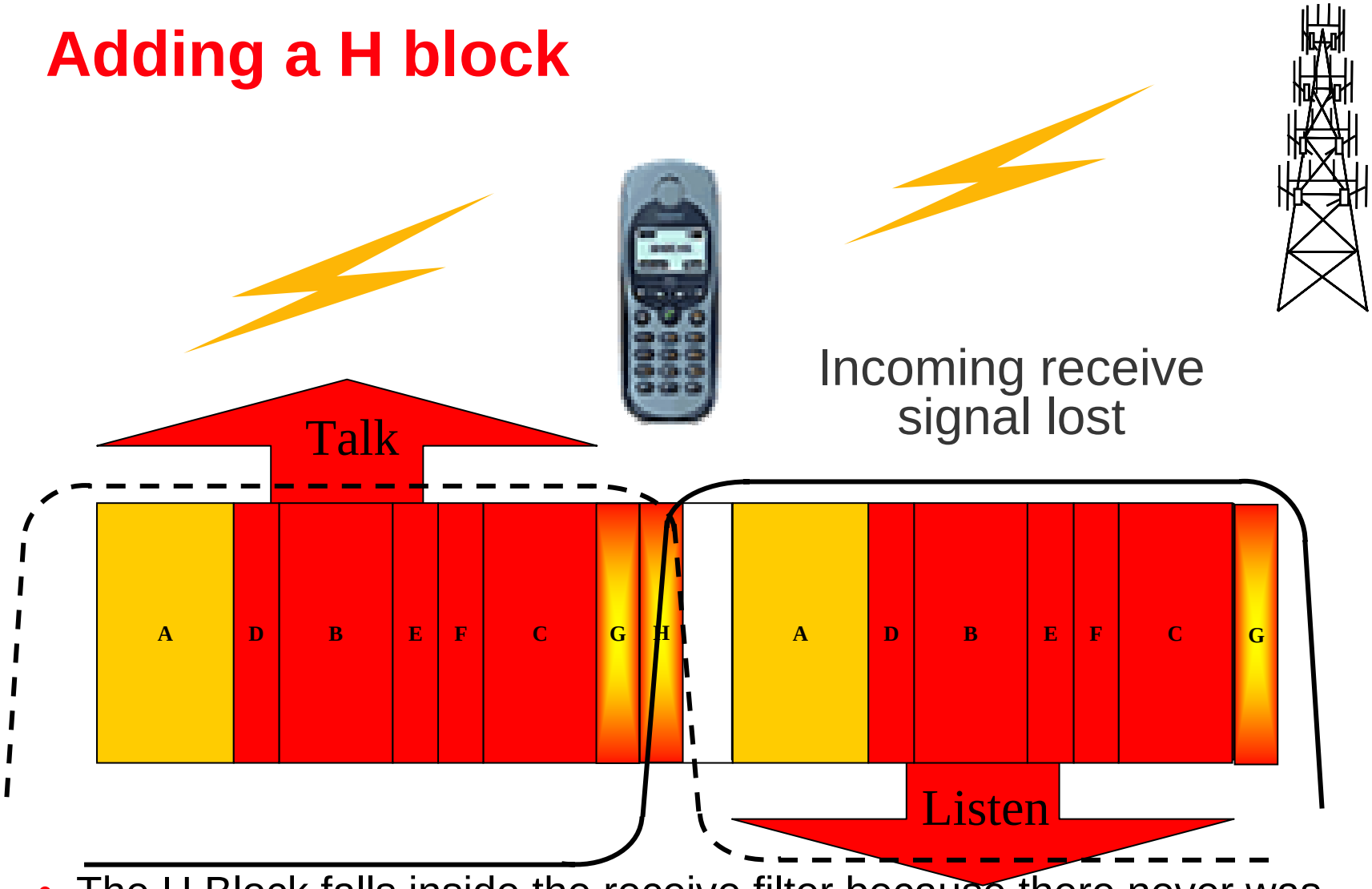
- Because the transmit filter passes the signal to the base station and and cleans up the transmit emissions and the receive filter only allows signals in its band to enter, both filters working together enable handsets to work. This is the main function of a duplex filter. filter. Receive signal is OK.

Adding a G block



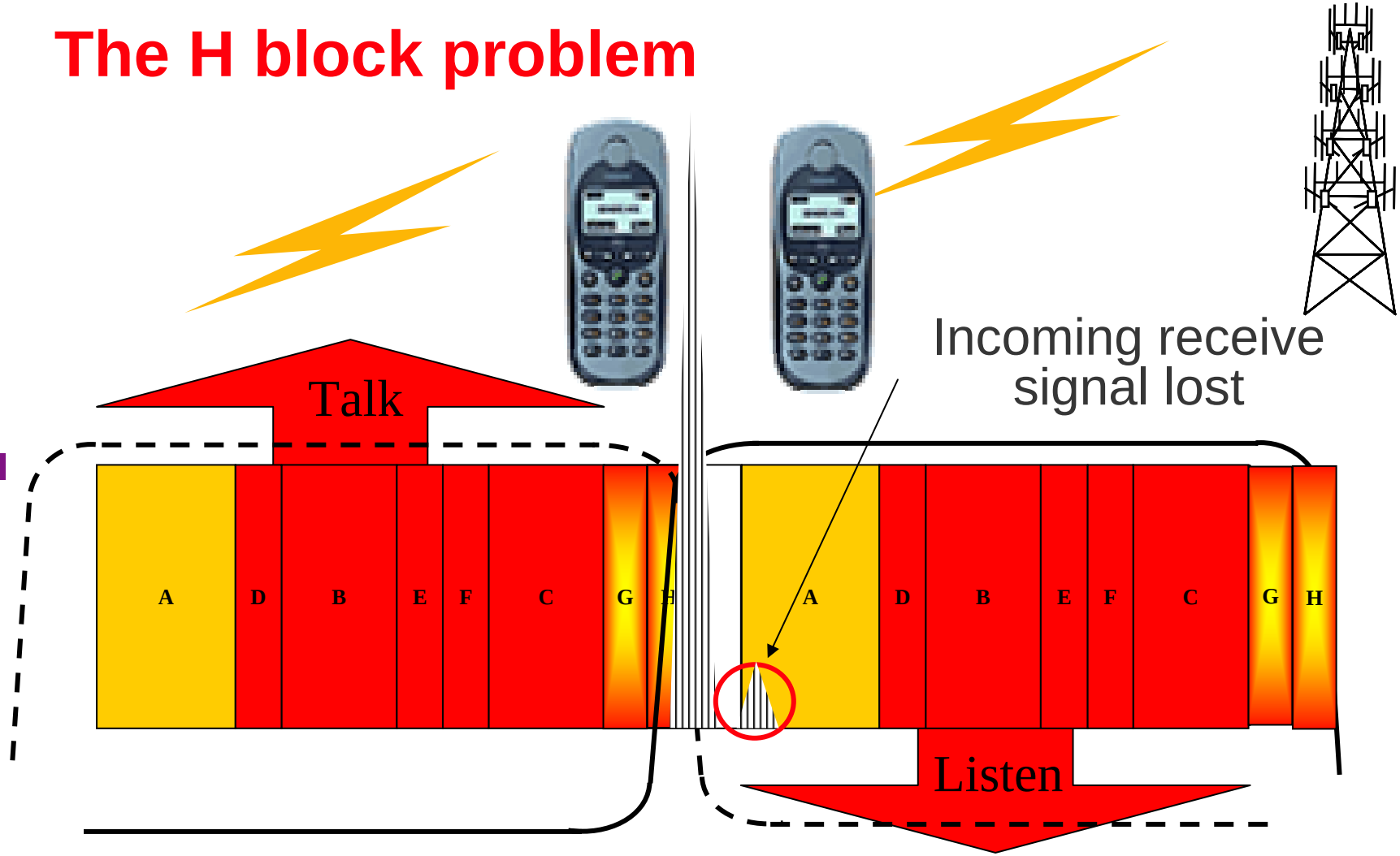
- The new “G Block” fits inside the transmit filter and outside the receive filter.
- PCS handsets can filter the G Block transmit signal power out.
- The G Block transmission emissions must be addressed in the service rules and should meet TIA standards.

Adding a H block



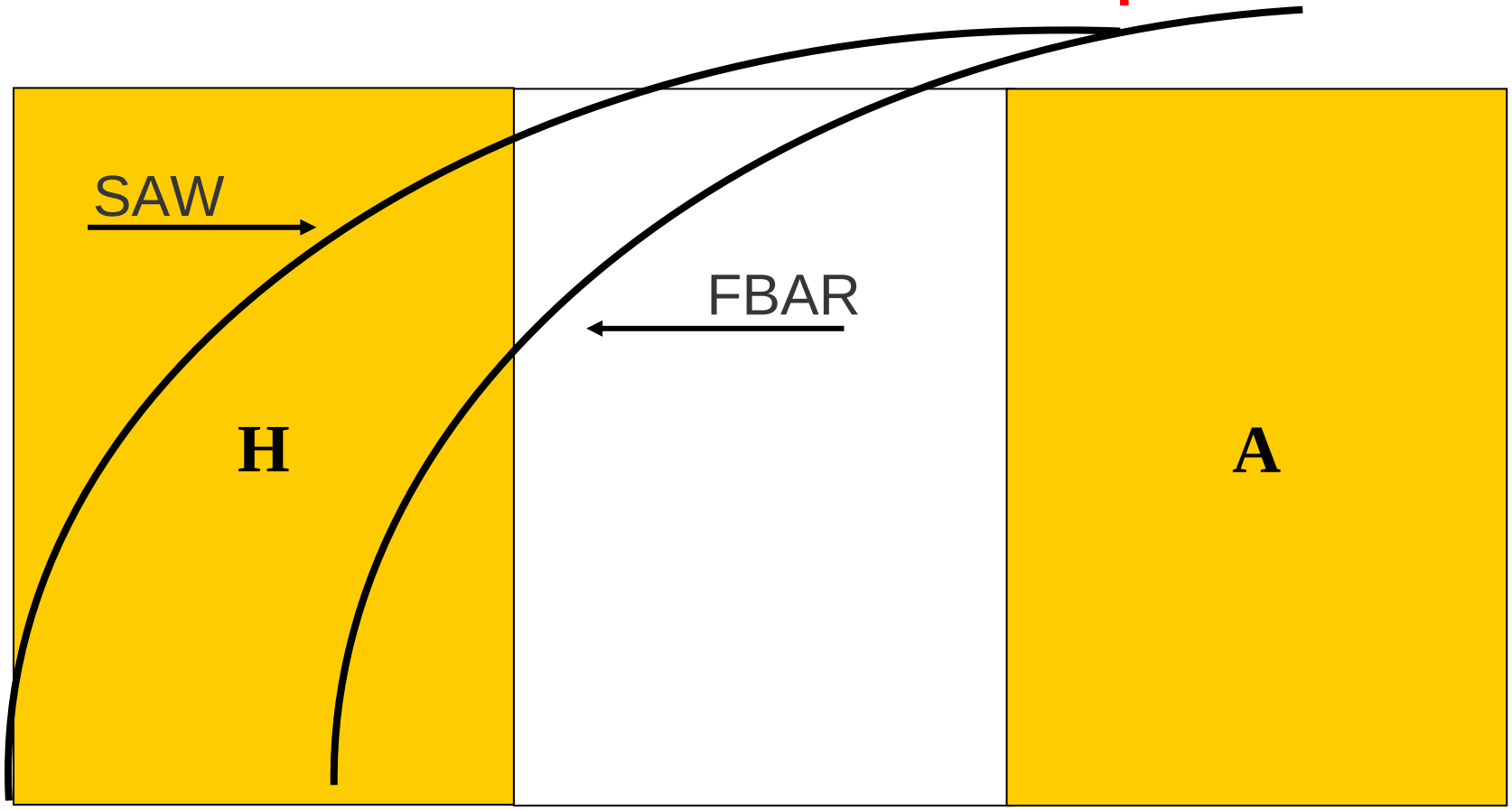
- The H Block falls inside the receive filter because there never was was an H Block anticipated.
- PCS handsets operating at typical handset levels will “hear” the H H Block transmit power and when nearby another active H device, device, the PCS handset will experience interference.

The H block problem



- PCS handsets cannot block signals from a new H device.
  - New filters to protect interfering signals have not even been considered by considered by most manufacturers.
- A PCS handset near a transmitting H Block device may not ring!
- PCS customers will experience dropped calls and voice quality degradation.

Illustration of the H Block "overload" problem



- **The duplexers in millions of PCS handsets deployed today would be "listening" to the H Block transmissions.**
- **These duplexers do not filter out the H Block.**
- **H Block transmit filter is irrelevant to this problem.**

H Block Test Results Summary

PCS Handsets:

- Direct Conversion technology has become favored by manufacturers and millions of Direct Conversion handsets are deployed in the marketplace.
- Test data of Direct Conversion technology demonstrated those handsets would would experience significant “overload” interference from H block transmissions. transmissions.
- When performing the same tests using C and G block signals as the interfering interfering sources, no “overload” interference was created.
- Millions of existing customers receive PCS services using these handsets today.

PCS Duplex filters:

- While there are several types of duplexers amongst many manufacturers providing duplex technology, SAW filters dominate the marketplace.
- Degradation of all duplexer performance varies significantly by manufacturer manufacturer and temperature range.
- Response in duplexer performance to temperature shifts suggests that “overload” interference problem can be attributed to all H block channels – not not just the channel closest to the PCS A block.

- The FCC must base H block allocation decision and service rules on on SAW and Direct Conversion technology parameters.
- Additional testing is required to confirm the scope of this problem.

See Appendix for Nokia test results detail

Appendices

- TIA Standards
- H Block Overload Test Results
  - Performed at Nokia Labs
- Motorola Comments
- Agilent H Block Presentation Does Not Tell The The Whole Story And Does Not Address SAW SAW Filters

TIA Standard

TIA Standards- Protection From Spurious Emissions From Transmit Signal

What the standard is and why we need it?

- The TIA standard on spurious emissions:.

  "The spurious emissions in the mobile station's receive band shall be less than - than -76 dBm measured in a 1 MHz resolution bandwidth for band classes 0, 1, 0, 1, 2, 4, 5, 6, 7, 8, 9, 10, 11 and 12. For band class 3, the spurious emissions emissions in the mobile station's receive band shall be less than -81 dBm measured in a 1 MHz resolution bandwidth."

- The TIA standard was designed to protect the PCS receive band noise floor between 1930 to 1990 MHz MHz from spurious emissions.
- The result is PCS handsets can operate when multiple handsets are engaged in a call, without the the need to separate them by a certain distance.

Transmit Signal - Overload

What is Overload?

- Wireless Telecom voice technologies refer to overload overload as “receiver blocking”. The TIA standard, for for example, defines receiver blocking as:
  - ***“TIA 3.5.5.1 Definition*** *- The receiver blocking characteristic is a measure of the receiver’s ability to receive a CDMA signal at its assigned channel frequency in the presence of a single tone on frequencies other than those of the adjacent channels, without this unwanted input signal causing a degradation of the performance of the receiver beyond a specified limit.”*
- H Block frequencies are effectively “In-Band” to millions of PCS handset receivers and therefore should should be categorized as in-band interferers.

H Block Overload Test Results Performed at Nokia Labs

H Block

Overload Tests Results
Single Tone Desensitization (Overload) and Duplexer Testing Over Temperature

August 31, 2004

Overview / Conclusions

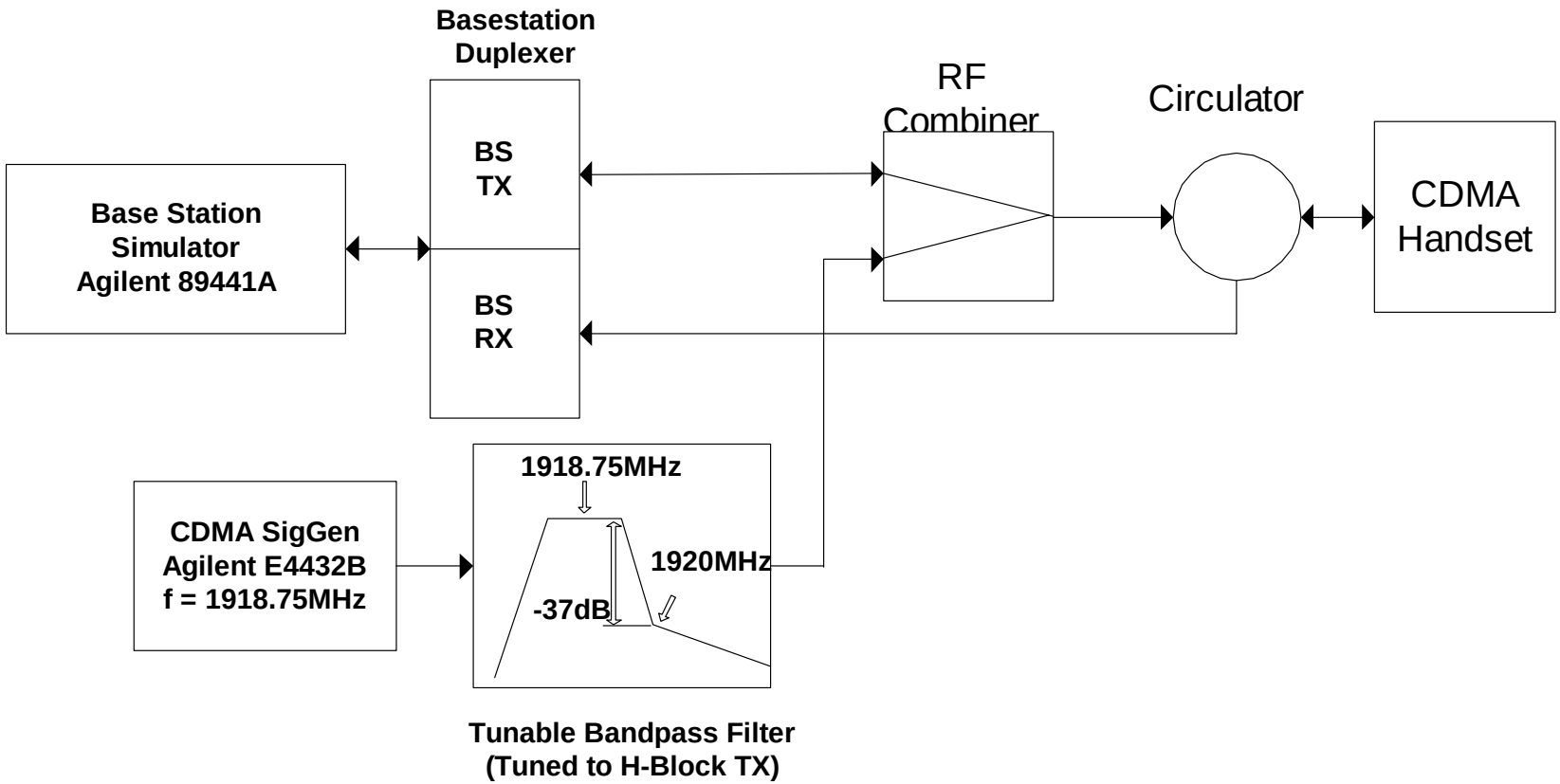
- Tests on the H Block were conducted at Nokia Labs during the last week of August 2004.
- The H Block transmit frequency impacts the current PCS duplexer receive band.
- Test results show harmful interference will occur to millions of existing existing PCS handsets in the presence of an H Block signal.
    - One active H Block device could prevent another nearby handset from from placing and receiving a call.
    - Both devices do NOT have to be engaged in a call.
    - In PCS today, all PCS handsets are fully operable and non-interfering interfering at any distance with respect to each other.
    - Performance of all duplexers vary dramatically over their normal operating temperature range.
- If H Block is allocated for mobile services, **significant** power limitations limitations (likely throughout the H Block transmit band) must be imposed **along with** the out-of-band emissions criteria set forth in PCS PCS industry standard, TIA 98-F, to avoid adverse impacts to PCS consumers.
- Alternatively, the Commission should consider allocating the H Block Block for low-power unlicensed or any other non-mobile service.

Table of Contents

Test Setup Parameters

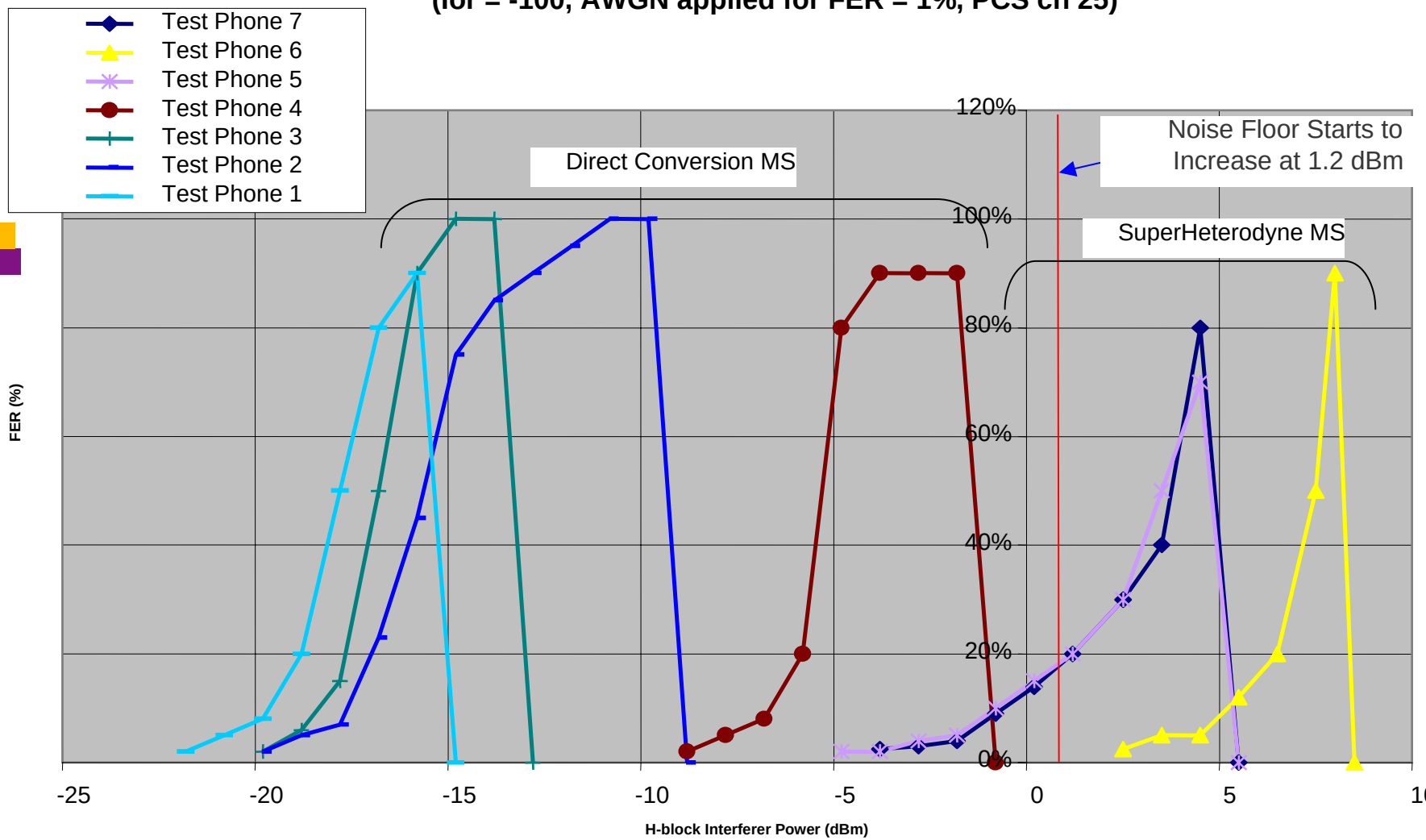
- Initial Test of PCS Rx channel 25 (1931.25 center freq) noise floor floor of CDMA signal generator
- Setup:
  - CDMA signal generator: E4433B
  - Per test plan: High channel Tx H block center freq = 1918.75 MHz with with 1.23 MHz bandwidth CDMA signal
  - Traffic channel = -15.6 dB
  - Pilot = -7 dB
  - Paging = -12
  - Sync = -16
  - Ambient Temp = 27 C
  - Measured with VSA 89441A
  - Path Setup: Signal generator -> isolator -> notch -> BPF (1920 tuned) -> VSA
- Both the C and G blocks were tested as interferers.
- Seven handsets from three manufacturers were tested.

Mobile Receiver Overload Test Setup



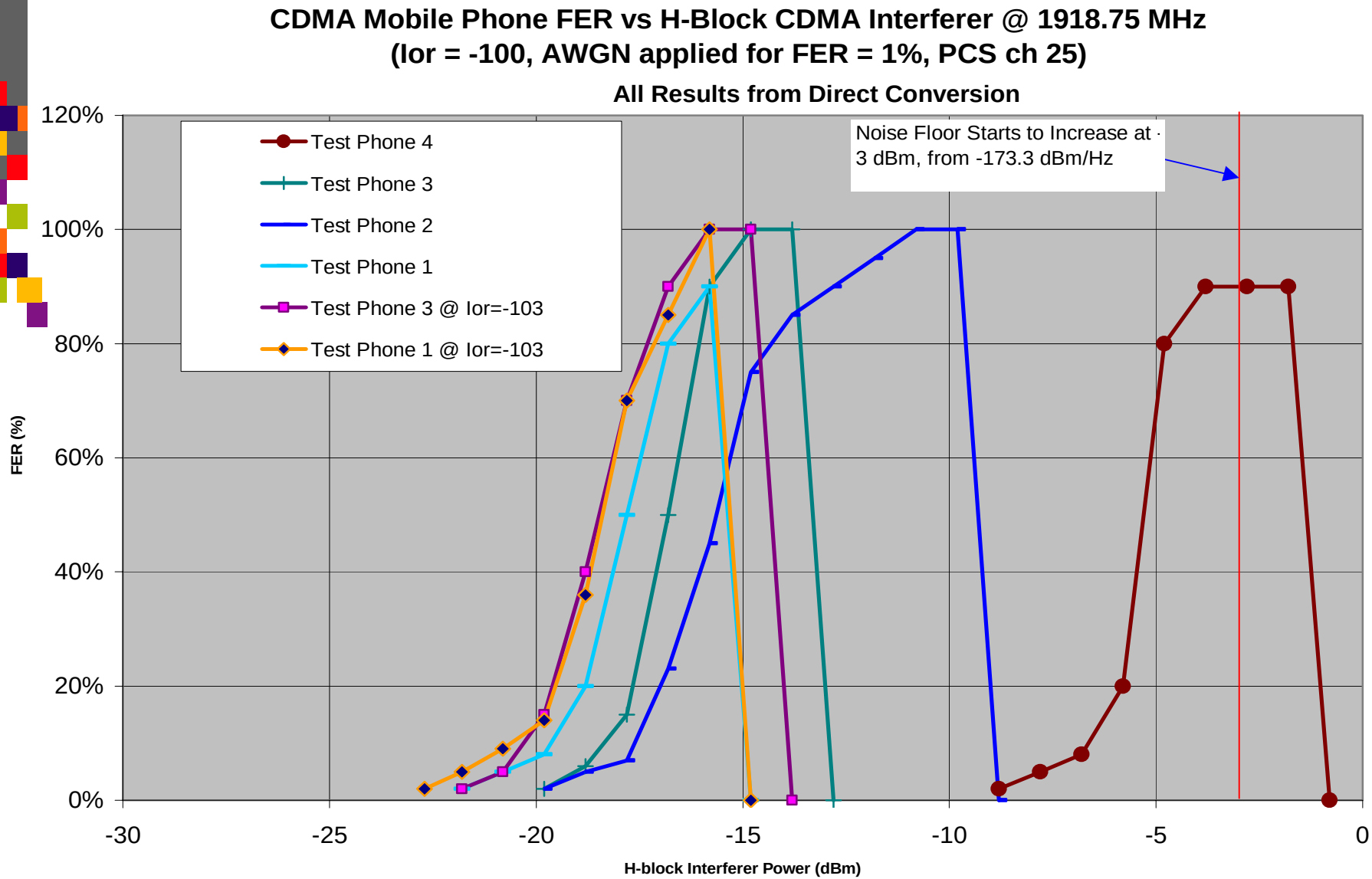
Nokia Labs Test Results – One

FER (%) vs. H Block RF signal power (dBm) at A block antenna port



Nokia Labs Test Results – Two

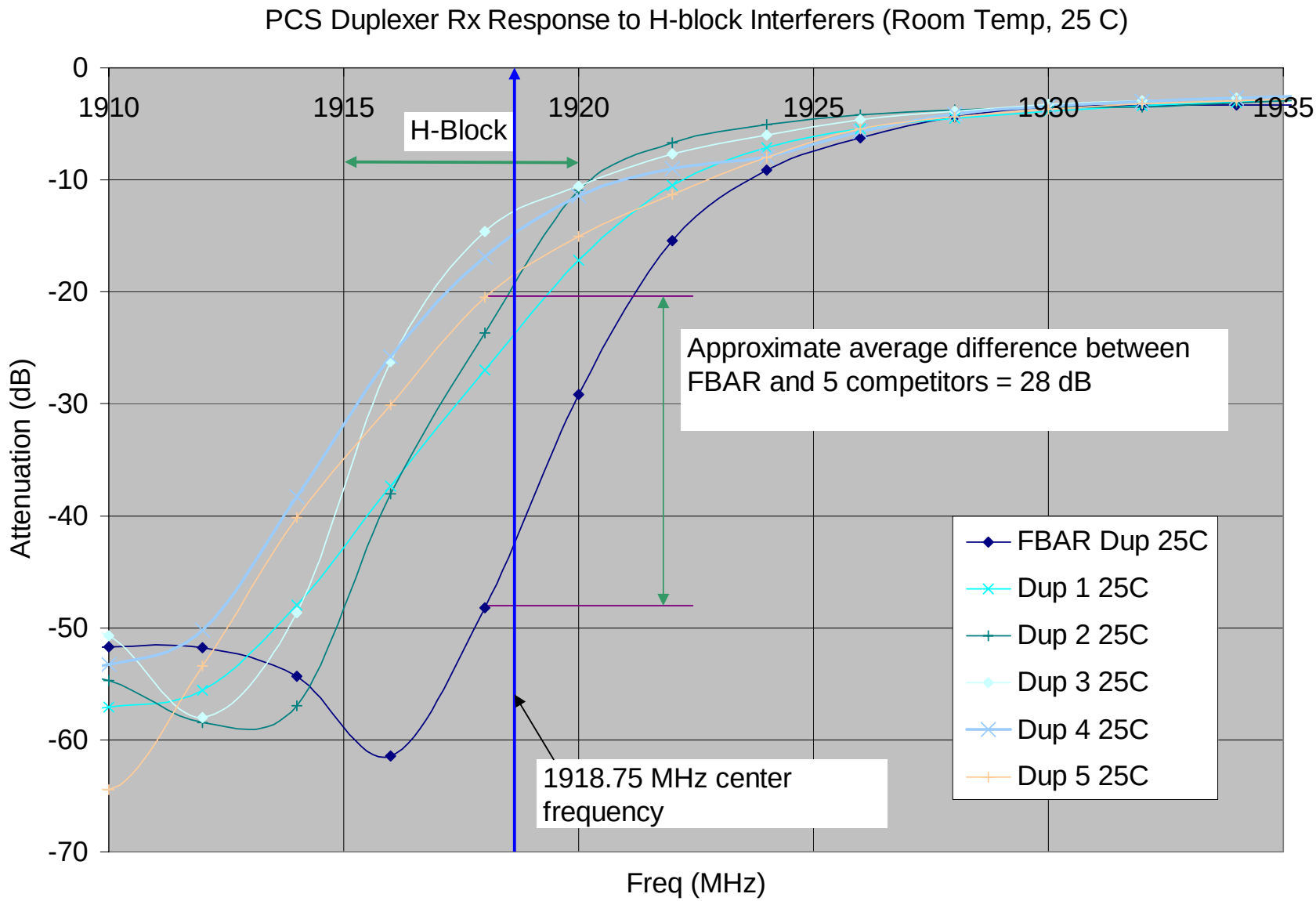
FER (%) vs. H Block RF signal power (dBm) at A block antenna port



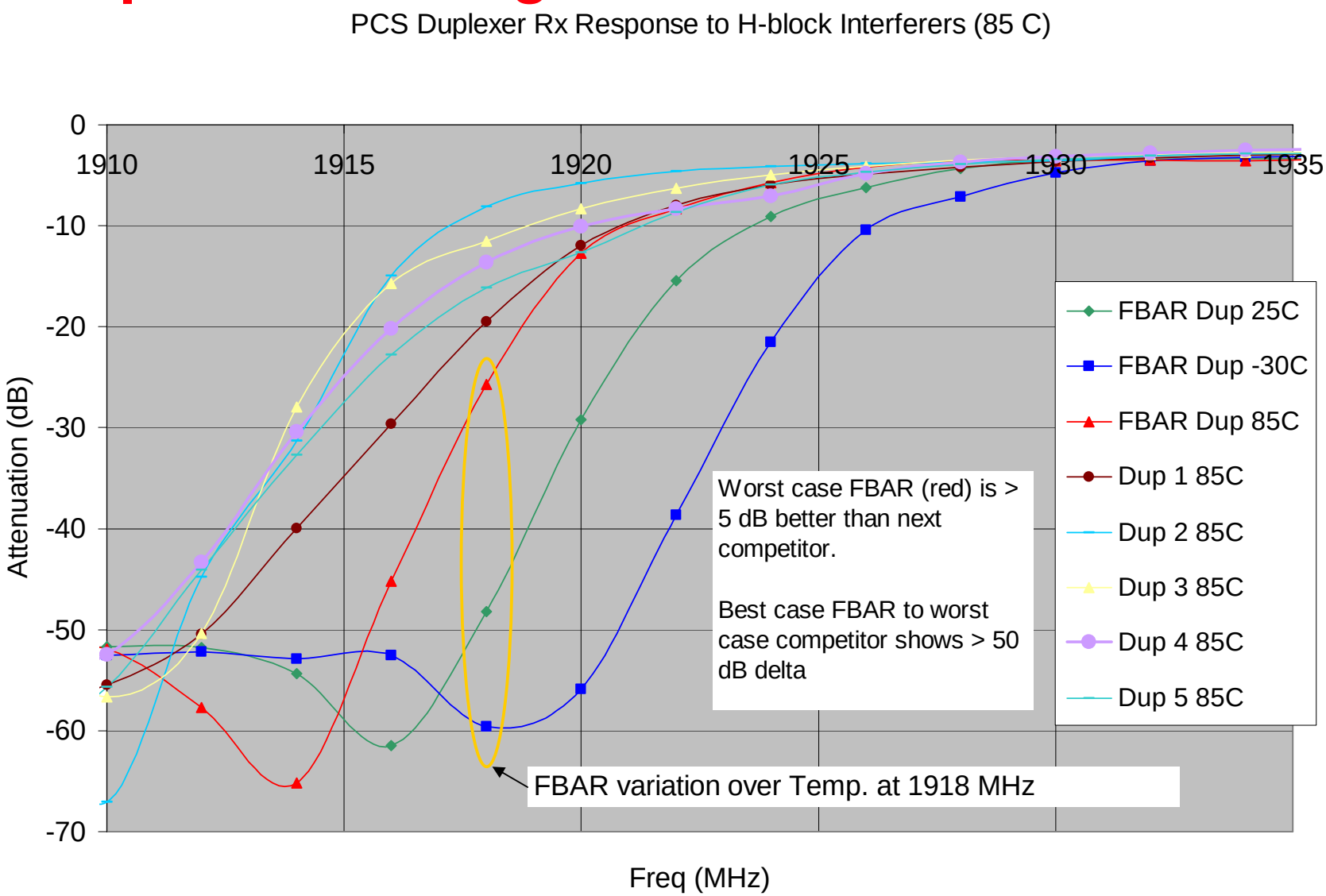
Test Results One and Two Summary

- Test data demonstrates that Direct Conversion Handsets employing SAW SAW filters (dominant filter in PCS handsets today) would experience significant “overload” interference from H block transmissions.
- Although the SuperHet handsets tested were less impacted, Direct Conversion technology has become favored by manufacturers and is now now widely deployed, with millions of handsets in the marketplace.
- When performing the same tests using C and G block signals as the interfering sources, no “overload” interference was created.
- The test data shows, for example, that if the H block phone were operated operated at 166 mW (less than 1/10th the operating power permitted for for mobiles under Part 24), it would cause an unacceptable 90 % Frame Frame Error Rate in test phone 3 one meter away.
- Millions of existing customers receive PCS services using these handsets handsets today.
- To put this into perspective, for example, more than 2 million Sprint subscribers are using test phone 3 today.

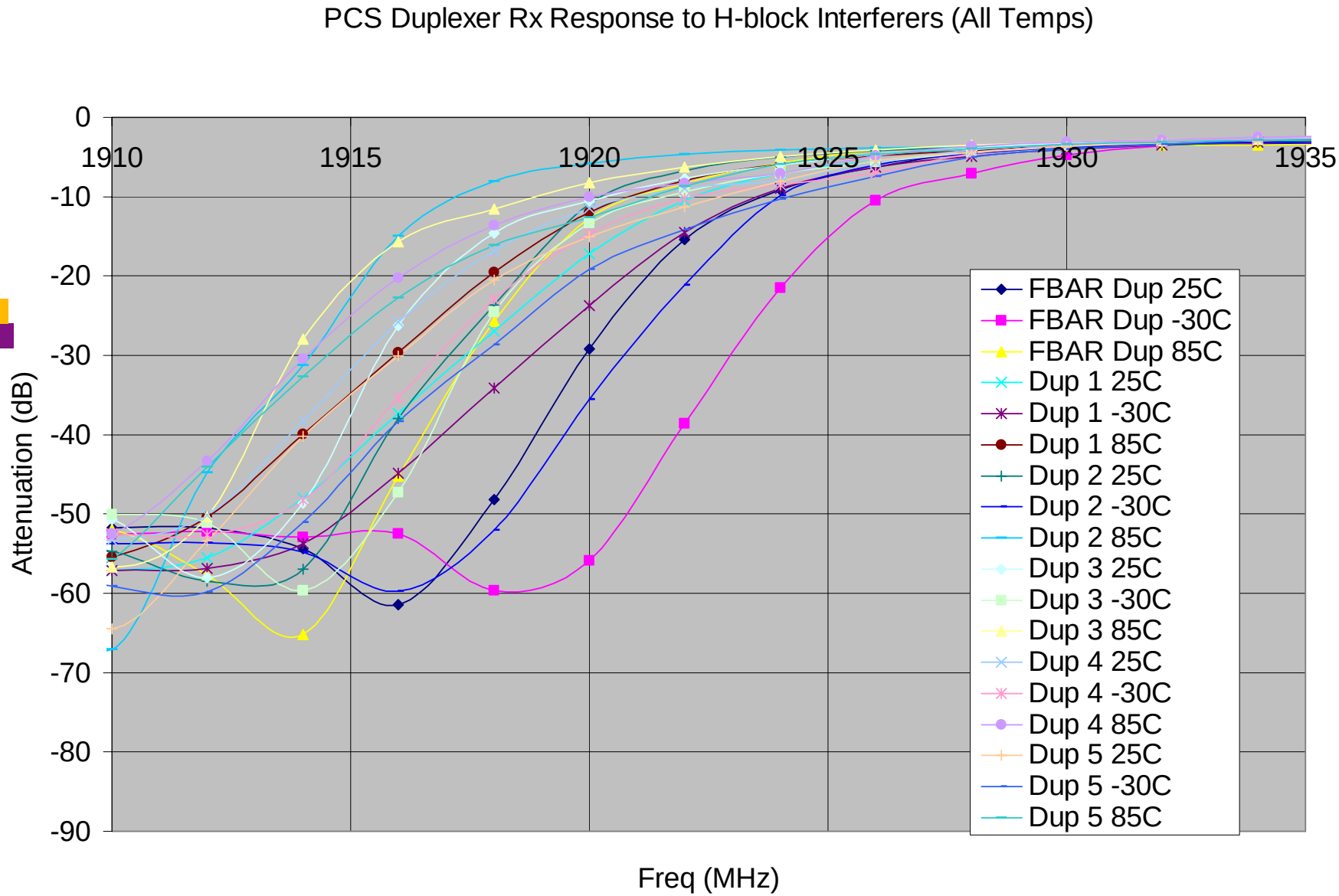
Duplexer Testing



Duplexer Testing



Duplexer Testing



Duplexer Testing Summary

- Attenuation and frequency variations are dramatic over the normal normal operating range of a duplexer – as the duplexer gets hotter, hotter, the performance degrades significantly.
- Higher operating temperatures result in less attenuation across the the entire H block.
- SAW filters are widely deployed in the marketplace and therefore therefore the FCC must base H block allocation decision and service rules on SAW technology parameters.
- Degradation of all duplexer performance varies significantly by manufacturer and temperature range.
- Response in duplexer performance to temperature shifts suggests suggests that “overload” interference problem can be attributed to attributed to all H block channels – not just the channel closest to to the PCS A block.
- Additional testing is required to confirm the scope of this problem. problem.

Motorola Comments

Motorola Comments

Motorola filed comments on April 14, 2003 in ET Docket 00-258, among other comments Motorola Motorola said…

- The *Third NPRM* incorrectly states that "it appears possible to reduce this this separation by 5 to 10 megahertz without leading to harmful interference interference to existing Broadband PCS systems." This belief appears to be be founded upon a Nextel ex parte filing in this proceeding that actually supports the feasibility of only a 5 MHz reduction in the duplex gap. This option would require PCS equipment to meet the industry out-of-band emission standards with a duplex gap of only 10 MHz. Such operation presently is not feasible using a single duplexer, nor does it appear to be be achievable in the foreseeable future.

- With only a 10 MHz duplex gap, mobile transmitters would not provide sufficient filtering to reduce emissions to acceptable levels. This problem problem would also exist for mobile receivers operating above 1930 MHz, MHz, because filters in these receivers would not be able to provide sufficient sufficient isolation from transmitters operating at frequencies as high as 1920 1920 MHz. These technological considerations preclude equipment availability and thus weigh heavily against re-designating more than 10 MHz MHz of additional spectrum for Broadband PCS.

Motorola Comments

July 20, 2004 comments reaffirm 2003 filing

Impact on use of G and H band for broadband PCS mobile applications:

- A-G band
  - Single duplexer
    - Cautiously feasible
    - Earliest products 3 years if Agilent or others successful
  - Split band Tx filter provides no help for Rx noise
  - Split band Rx filter can solve duplex problem but adds cost, size, loss
- A-H, or H band
  - No identified filter technology for Rx noise suppression to TIA levels
  - Split band filters result in unacceptable Rx degradation
  - Motorola believes distances on the order of 1m is minimum required
- Conclusion
  - H band is not feasible at this time or near future
  - G band carries risk in filter feasibility and cost with single supplier identified identified
  - G band may require higher PA power due to filter losses
  - Motorola is not in favor of split band filter options (useful mainly for Rx)

Agilent H Block Presentation

The Agilent H Block Presentation Does Not Tell The Whole Story And Does Not Address SAW Filters

- Agilent does not represent the majority of the filter base used in used in handsets today.
- Agilent's H Block presentation states that "Industry Standard Standard value for minimum duplexer rejection (Rx filter in Tx Tx band) is 50 dB."
- They also state their FBAR Duplexer has only 15 dB of attenuation at the "top of H Block"
- A calculation is then shown considering 1 meter of free space space loss to compensate for the short fall in the Industry Standard.
- The resulting calculation concludes that "…operation above16.5 above16.5 dBm in channel 4 or above 21.5 dBm in channel 3 could cause interference.
- Reliance on Agilent's specifications is not a fair representation of representation of the H Block problem with respect to SAW filters, which dominate the marketplace and, in any event, show show that even with respect to FBAR filters, overload from an H an H Block signal remains a concern.